MAJOR ELEMENT CHEMICAL COMPOSITIONS AND CHEMICAL TYPES OF CHONDRULES IN UNEQUILIBRATED E, O, AND C CHONDRITES FROM ANTARCTICA

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Abstract: The major element chemical compositions of most chondrules correspond to the compositions of mixtures of olivine and low-Ca pyroxene with constant amounts of feldspar (or feldspathoid) and high-Ca pyroxene; other chondrules contain variable amounts of normative feldspar (or feldspathoid), high-Ca pyroxene, spinel, SiO_2-minerals, etc. The Al, Na, and K contents of most chondrules reflect the composition of the ternary feldspar (An-Ab-Kf) of the chondrule precursor material, and chemical types of chondrules (KF, SP, IP, CP) are defined on the basis of the proportions of Al, Na, and K. The KF chondrule type is restricted to brecciated LL chondrites. The CP type is rare, and occurs mainly in carbonaceous chondrites. The SP and IP types are most abundant in all chondrites; the relative frequency of SP and IP types differs among brecciated LL type chondrites, ordinary chondrites (except for the brecciated LL type), and carbonaceous chondrites.

1. Introduction

The chemical compositions of chondrules in unequilibrated chondrites show a wide range (WALTER, 1969; OSBORN *et al.*, 1973, 1974; McSWEEN, 1977; DODD, 1978a, b; FODOR and KEIL, 1978; FREDRIKSSON, 1982), although the chemical data are not so abundant. The major problems relating to the chemical compositions of chondrules are: (i) How widely do these compositions range? (ii) Are there gaps in the compositional spectrum? (iii) Are there systematic correlations between the chemical compositions and textures of chondrules? (iv) Are there systematic differences in the compositions of chondrules among the E, H, L, LL, and C chemical groups of chondrites?

In order to investigate these questions, the author analyzed chondrules in several Antarctic unequilibrated chondrites: Y-691 (E3-4), Y-790986 (H3-4), ALH-77299 (H3), Y-74191 (L3), ALH-77015 (L3), ALH-764 (LL3), Y-74442 (LL3-4), ALH-77003 (C3), and Y-790992 (C3).

2. Analytical Method

The chondrules were analyzed using the defocussed beam (about 50 to 60 microns diameter) of an electron-probe microanalyzer. The defocussed beam was moved slowly over a chondrules in a thin section, covering its area three or more times. The counting time was 100 s for small chondrules, and 200 s for large chondrules. Small amounts of opaque minerals such as Fe-Ni metals and troilite occur in most chondrules; the defocussed beam was moved so as to miss these. Thus the chemical compositions reported in this paper are of the silicate portions of chondrules only. The microprobe correction method of IKEDA (1980) was used.

3. Samples Studied

In general, chondrites are composed mainly of chondrules, refractory or lithic inclusions (or aggregates), mineral fragments, and matrix. However, the definition of chondrules has never been clearly established. In this paper, "chondrules" are defined to be all materials which crystallized from undercooled silicate melts (MCSWEEN, 1977). Thus "chondrules" in this paper means "chondrules in the broad sense", which includes droplet chondrules (KIEFFER, 1975), clast chondrules (DODD, 1981), lithic chondrules (KING and KING, 1978), chondrule fragments (KING and KING, 1978), and so on.

Most of the chondrules in all C2 chondrites and some C3 chondrites are "altered chondrules", and their chemical compositions have been changed from the original ones (IKEDA, 1983). This paper deals only with fresh chondrules, which are free from any alteration.

Following are comments on the chondrites that were studied.

3.1. Y-691

This chondrite is of class E3-4 according to Photographic Catalog of the Selected Antarctic Meteorites (YANAI, 1981), and its petrology and petrochemistry were reported by OKADA (1975), OKADA *et al.* (1975), and SHIMA and SHIMA (1975). It contains large amounts of olivine, and the MgO/(MgO+FeO) ratio of its pyroxene ranges from 0.995 to 0.915. Thus Y-691 is different from typical E chondrites, deviating in composition slightly towards H chondrites.

3.2. Y-790986 and ALH-77299

The Y-790986 chondrite is classified H3-4 by the Photographic Catalog of the Selected Antarctic Meteorites (YANAI, 1981). It is a massive aggregate of chondrules with minor amounts of inclusions, mineral fragments and matrix. Most of the chondrules are porphyritic types; radial-Px, barred-Ol, and devitrified glassy chondrules occur in minor amounts. Some chondrules include clean brown glasses as their groundmass. One radial-Px chondrule about 900 microns in diameter includes several SiO_2-mineral (probably tridymite) grains of a few microns diameter.

ALH-77299 is an H3 chondrite according to the Antarctic Meteorite Newsletter, Vol. 2 (1979), in which the brief description of this chondrite is given by B. MASON.

3.3. Y-74191 and ALH-77015

The Y-74191 chondrite is classified L3, and its petrology and petrochemistry have been discussed by IKEDA and TAKEDA (1979a) and KIMURA and YAGI (1980).

ALH-77015 is an L3 chondrite, and its petrology and petrochemistry were studied by NAGAHARA (1981) and FUJIMAKI *et al.* (1981), who reported the chemical compositions of chondrules in it. One Ca- and Al-rich chondrule in this chondrite was described by NAGAHARA and KUSHIRO (1982).

3.4. ALH-764 and Y-74442

Unequilibrated LL chondrites are divided into two subtypes, non-brecciated and brecciated. The former contain many chondrules and seem to have escaped intense brecciation; they resemble many unequilibrated L chondrites. The latter contain few chondrules and have suffered intense brecciation; they resemble the lunar regolith in texture.

The ALH-764 chondrite is a non-brecciated type of class LL3. The petrology of this chondrite was studied by IKEDA (1980).

The Y-74442 chondrite is a brecciated type of LL3-4. The petrology and petrochemistry of this chondrite were reported by IKEDA and TAKEDA (1979b).

3.5. ALH-77003 and Y-790992

ALH-77003 and Y-790992 are C3 chondrites, and are similar to each other. The petrology of ALH-77003 was reported by IKEDA (1982).

The Y-790992 chondrite is an aggregate of chondrules, inclusions, mineral fragments, and matrix. The inclusions are fine-grained CAI's, amoeboid olivine inclusions, dark inclusions, and other lithic inclusions. The chondrules show a variety of textures, porphyritic to granular types being common. Chondrule sizes range from 1.7 mm to several tens of microns in diameter, most chondrules being smaller than 0.6 mm. Micro-chondrules whose diameters are smaller than about 100 to 150 microns often show spherulitic textures.

4. Chemical Compositions of Chondrules

Newly-determined chemical compositions of fresh chondrules in Y-691, Y-790986, ALH-77299, ALH-77015, and Y-790992 are shown in the Appendix. In addition to these, the compositions of chondrules in Y-74191, ALH-764, Y-74442, and ALH-77003 were taken from IKEDA and TAKEDA (1979a), IKEDA (1980), IKEDA and TAKEDA (1979b), and IKEDA (1982), respectively.

Most chondrules consist largely of SiO_2, MgO, FeO, Al_2O_3, CaO, and Na_2O, in that order of abundance, with minor amounts of Cr_2O_3, TiO_2, MnO, and K_2O. SiO_2, MgO, and FeO alone usually sum to more than 85 wt %, although some chondrules have high Al_2O_3, CaO, and/or Na_2O contents.

4.1. Chondrules of all the samples studied

The compositions of about 500 chondrules from all the chondrites studied are plotted in Fig. 1. As shown in Fig. 1a, the feldspathic components of chondrules plot in a limited area which is bordered by the solubility limit of the ternary feldspar (anorthite-albite-potassium feldspar) at a temperature of about 1100 K (IKEDA, unpublished data). Note that chondrules never fall in the region below the sodalite-potassium feldspar join, to within the analytical error. These observations are consistent with the idea that the original materials of chondurles, prior to chondrule-formation, con-

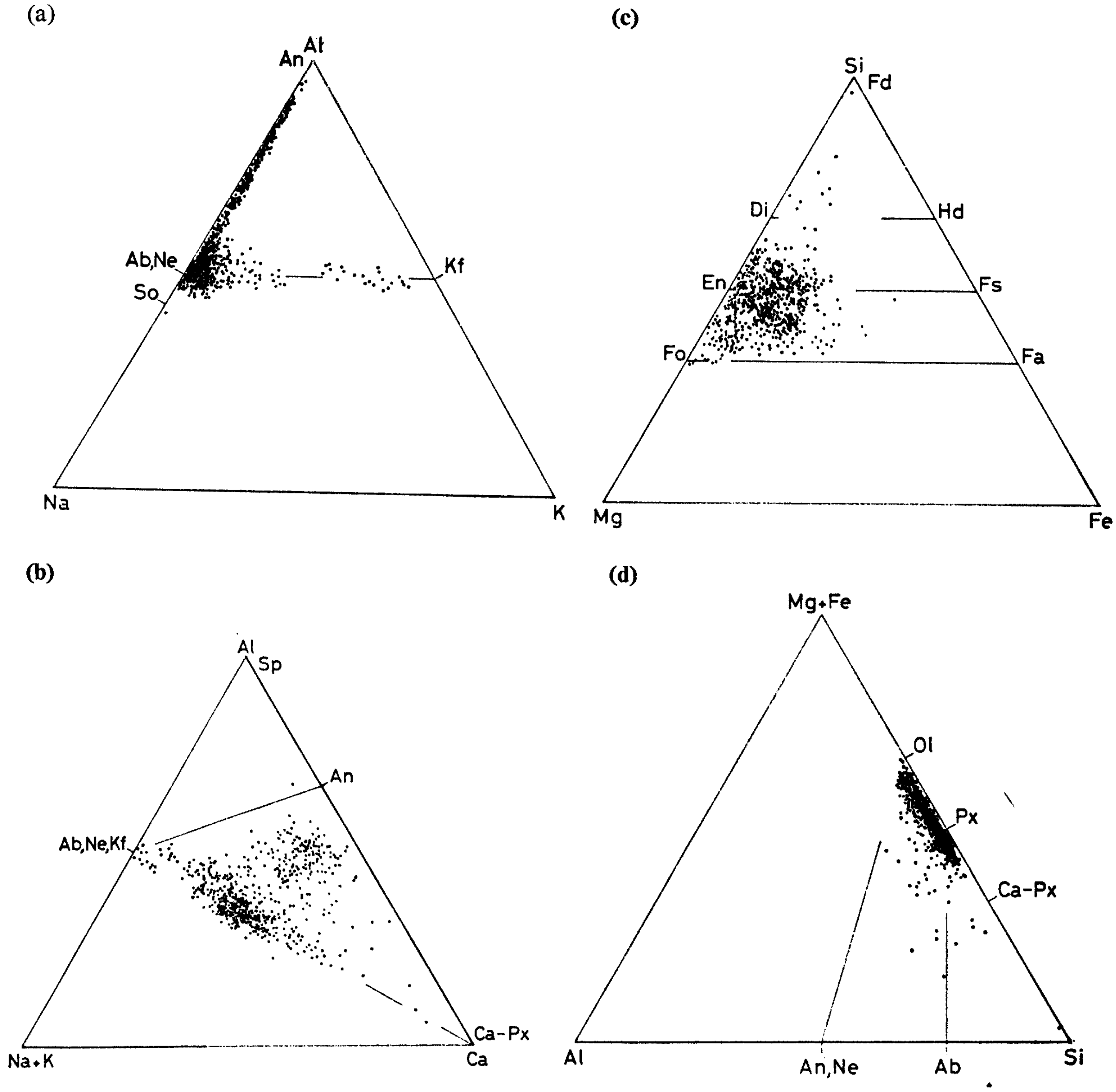

Fig. 1. Compositions (atomic percents) of about five hundred chondrules in Y-691 (E), Y-790986 (H), ALH-77299 (H), Y-74191 (L), ALH-77015 (L), ALH-764 (LL), Y-74442 (LL), ALH-77003 (C), and Y-790992 (C). An, Ab, Ne, So, Kf, Sp, Ca-Px, Fd, Di, Hd, En, Fs, Fo, Fa, Ol, and Px stand for anorthite, albite, nepheline, sodalite, potassium feldspar, spinel, high-Ca pyroxene, feldspar, diopside, hedenbergite, enstatite, ferrosilite, forsterite, fayalite, olivine, and low-Ca pyroxene, respectively.

tained feldspars and/or feldspathoids as the main Al- and alkali element-bearing components.

Figure 1b shows that the compositions of most chondrules plot in or near the triangle defined by the plagioclase solid solution (from An to Ab and Kf) and high-Ca pyroxene. Most of them plot in a loose cluster paralleling the plagioclase join, indicating that most of the original materials of chondrules comprised plagioclase and high-Ca pyroxene in a nearly constant ratio, although a smaller number of chondrules were rich or poor in high-Ca pyroxene. The scarcity of points in the triangle defined by Sp-

An-Ab shows that spinels were not a main phase in the chondrule precursor material.

As shown in Fig. 1c, the atomic ratios of Mg/(Mg+Fe) in most chondrules are greater than about 0.6, although some chondrules are fairly rich in ferrous iron. Most chondrules have Si/(Si+Mg+Fe) ratios of 0.3 to 0.65.

Figure 1d shows that the majority of chondrule compositions concentrates in the region parallel to the side of the triangle bounded by olivine and low-Ca pyroxene and their ratios of Al/(Al+Si+Mg+Fe) are mostly less than 0.07. This means that the principal phases of most chondrule precursor materials were olivine and low-Ca pyroxene together with a constant amount of feldspar (or feldspathoid), consistent with DODD's observation for chondrules in the Manych chondrite (DODD, 1978a, b).

In summary, the chemical compositions of chondrules are controlled mineralogically, indicating that the chondrules were produced from precursor materials consisting of mineral aggregates. The precursor materials of the most chondrules were composed mainly of olivine and low-Ca pyroxene together with lesser but nearly constant amounts of high-Ca pyroxene and feldspar (and/or feldspathoid). The original materials of a few chondrules, however, included abundant amounts of high-Ca pyroxene, plagioclase, spinel, and/or SiO_2-minerals.

4.2. Comparison of the compositions of chondrules in O, E, and C chondrites

The chemical compositions of chondrules in six ordinary (O) chondrites (Y-790986, ALH-77299, Y-74191, ALH-77015, ALH-764, and Y-74442), an E chondrite (Y-691), and two C chondrites (ALH-77003 and Y-790992) are separately plotted in Figs. 2 to 5.

Figure 2 shows that K-rich chondrules occur only in O chondrites, and that the Na-rich chondrules in C chondrites have low and nearly constant K contents in comparison to those in O and E chondrites.

Figure 3 shows that chondrules having low Ca/(Al+Na+K+Ca) ratios occur only in O chondrites, and that the chondrules in C chondrites are poorer in alkalis as a whole than the chondrules of O and E chondrites.

As shown in Fig. 4, the chondrules in E chondrite are magnesian, although their Mg/(Mg+Fe) ratios are ovrelapped by those of O and C chondrites. The chondrules in C chondrites can be divided into two subtypes, magnesian and ferrous, by the limiting Mg/(Mg+Fe) ratio of 0.65 (IKEDA, 1982). The Mg/(Mg+Fe) ratios of chondrules in O chondrites, on the other hand, range continuously from 0.97 to less than 0.60.

As shown in Fig. 5, the chondrules in E chondrites are relatively rich in Si and contain constant amounts of Al, while the chondrules of C chondrites are relatively poor in Si and show the most variable Al contents.

4.3. Chemical types of chondrules

The chemical types (SP and IP) of chondrules in the ALH-764 chondrite were defined by IKEDA (1980). In this section, a full definition of the chemical types is given on the basis of the ratios of Al, Na, and K, which mainly reflect the feldspar compositions of the chondrule precursor.

A compositional hiatus exists between K-rich and K-poor chondrules, as shown in Fig. 1a. The hiatus is at about 0.40 to 0.55 of K/(Na+K) atomic ratios, and chon-

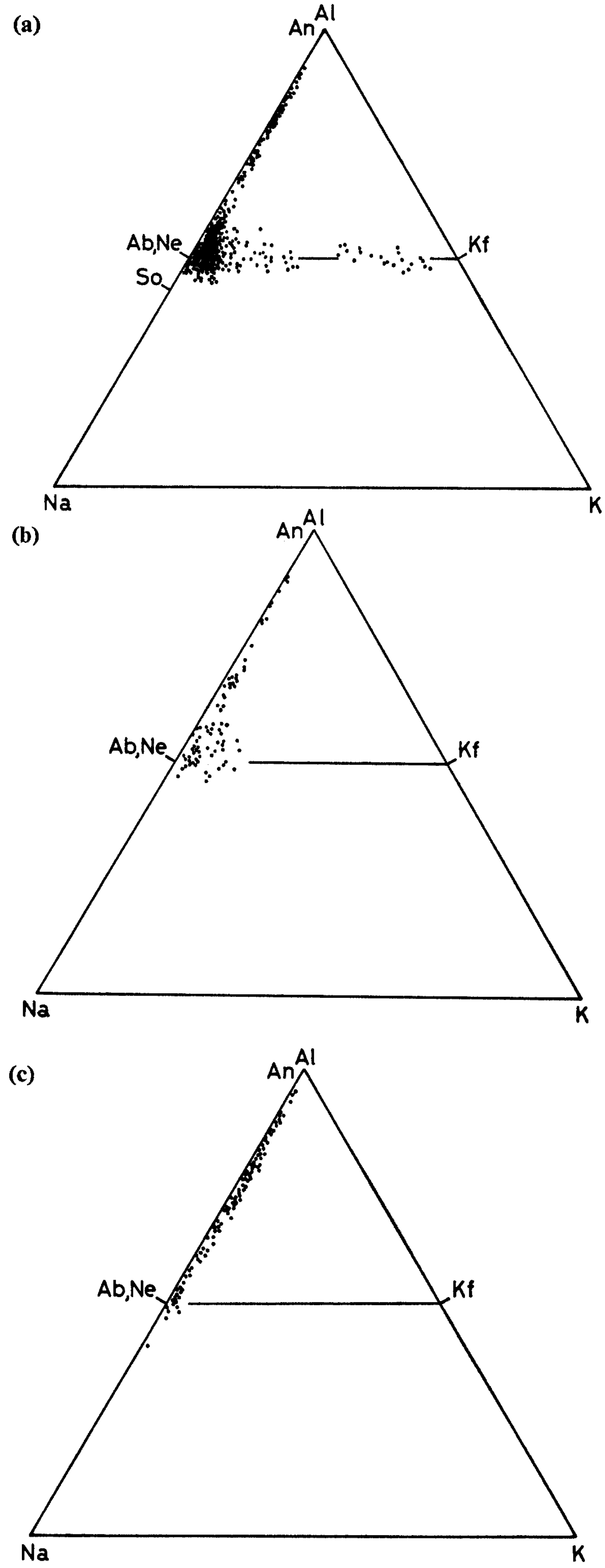

Fig. 2. Al-Na-K plots of chondrules from different chondrite types (atomic percents). Abbreviations are the same as those in Fig. 1. (a) Chondrules in ordinary chondrites (Y-790986, ALH-77299, Y-74191, ALH-77015, ALH-764, and Y-74442). (b) Chondrules in an E chondrite (Y-691). (c) Chondrules in C chondrites (ALH-77003 and Y-790992).

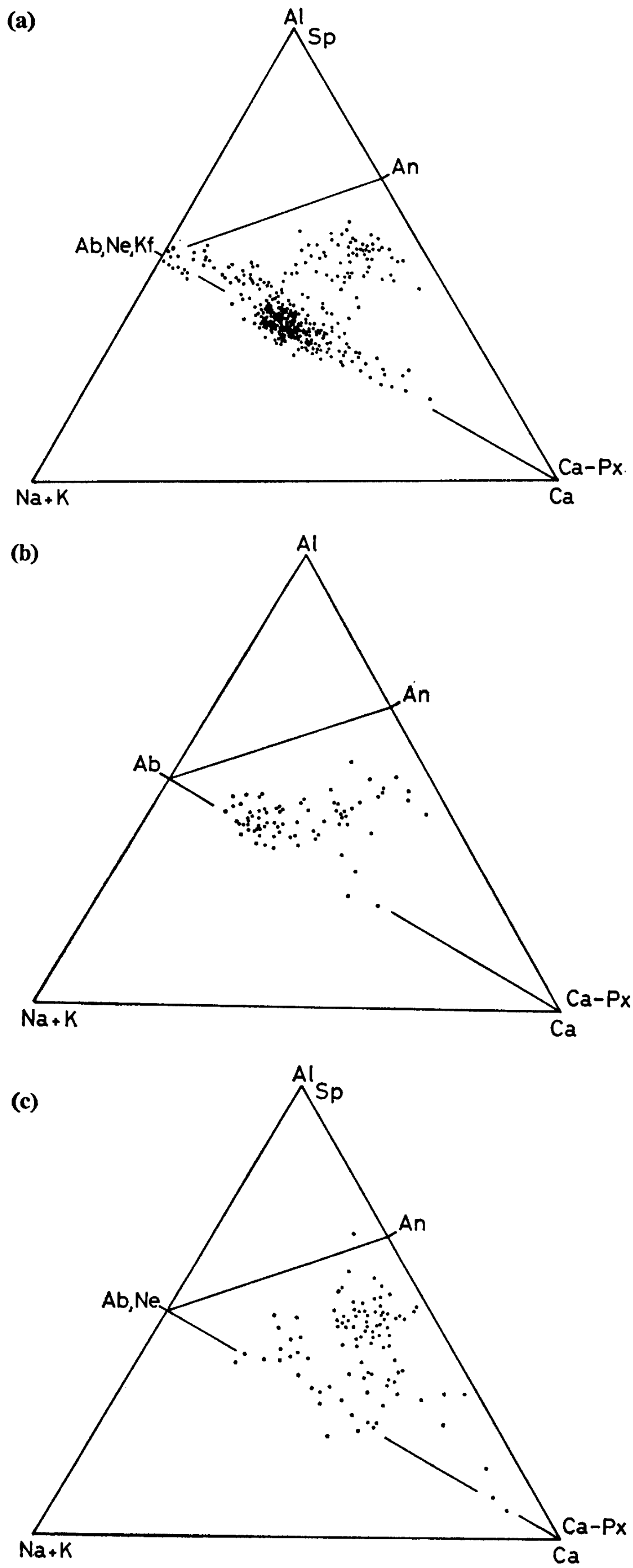

Fig. 3. Al-alkali-Ca plots of chondrules from different chondrite types (atomic percents). Abbreviations are the same as those in Fig. 1. (a) O chondrites. (b) E chondrite. (c) C chondrites.

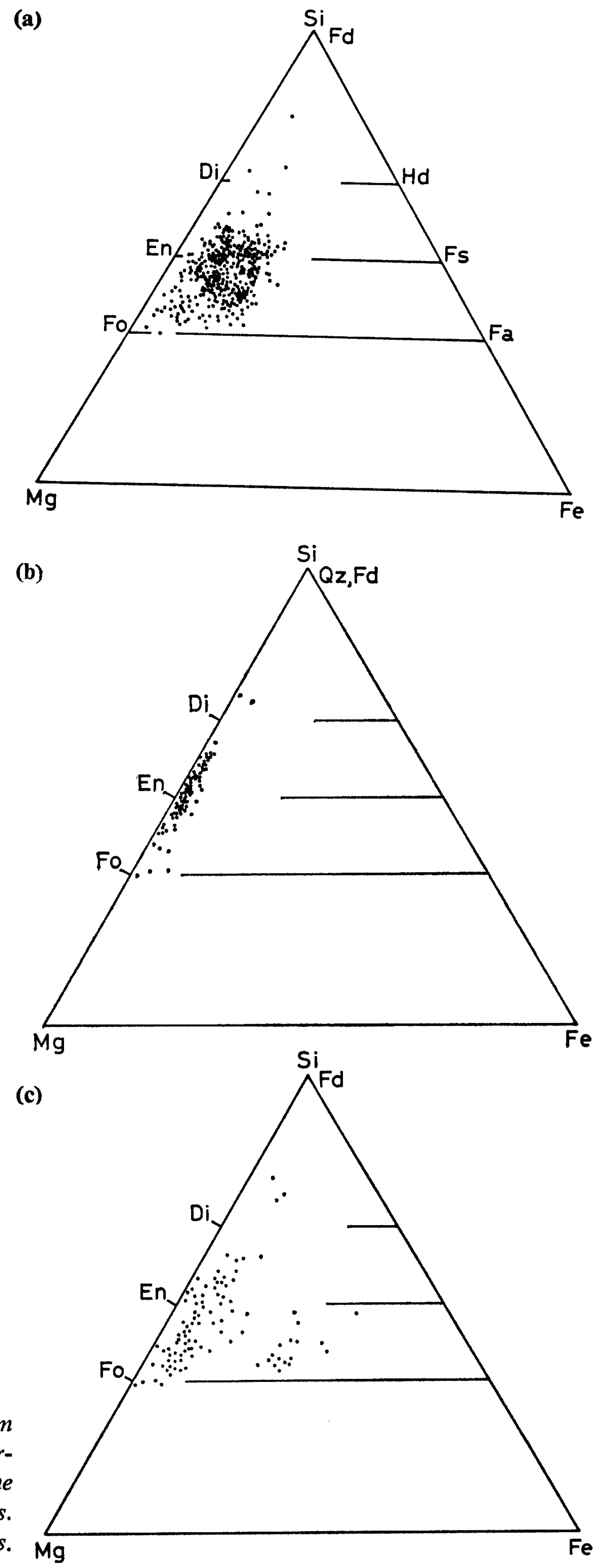

Fig. 4. Si-Mg-Fe plots of chondrules from different chondrite types (atomic percents). Abbreviations are the same as those in Fig. 1. (a) O chondrites. (b) E chondrite. (c) C chondrites.

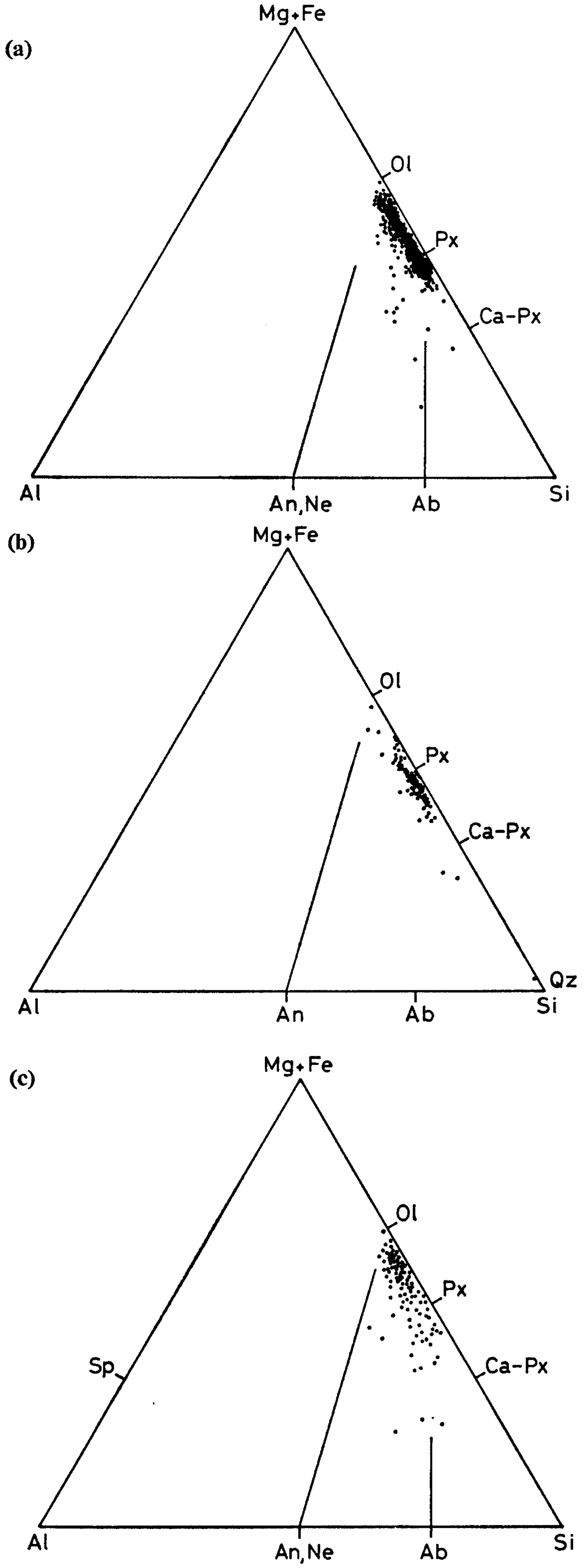

Fig. 5. (Mg+Fe)-Al-Si plots of chondrules from different chondrite types (atomic percents). Abbreviations are the same as those in Fig. 1. (a) O chondrites. (b) E chondrite. (c) C chondrites.

Table 1. Chemical types of chondrule (atomic ratios).

Chemical type	$\frac{Al}{Na+K+Al}$	$\frac{K}{Na+K}$
CP	>0.95	<0.5
IP	0.65< <0.95	<0.5
SP	0.40< <0.65	<0.5
KF	0.40< <0.65	>0.5

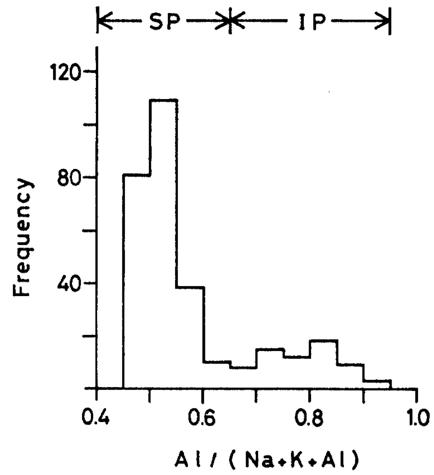

Fig. 6. Frequency distribution of the atomic ratio Al/(Al+Na+K) in about three hundred chondrules (KF types excepted) in the ordinary chondrites, Y-790986, ALH-77299, Y-74191, ALH-77015, ALH-764, and Y-74442.

Table 2. Subtypes of chondrules (atomic ratios).

	$\frac{Ca}{Al+Na+K+Ca}$	$\frac{Al}{Al+Si+Mg+Fe}$	$\frac{Si}{Si+Mg+Fe}$
Ca-poor	<0.1		
Al-rich	>0.1	>0.07	
Si-rich	>0.1	<0.07	>0.65
Ordinary	>0.1	<0.07	<0.65

Table 3. Frequency of subtypes of each chondrule chemical type.

	Ordinary	Al-rich	Si-rich	Ca-poor
CP	+	+	−	−
IP	++	+	−	−
SP	++	+	+	+
KF	+	−	−	−

++: abundant, +: common, −: absent.

drules rich in the Kf component are defined as the KF type by a ratio K/(Na+K)>0.50 (Table 1).

The frequency distribution of Al/(Al+Na+K) ratios of about three hundred chondrules (except for KF type) in O chondrites is shown in Fig. 6, where a bimodal distribution is apparent. The main sharp peak ranges from values of 0.40 to 0.65, and a minor broad peak (or plateau) lies between 0.65 and 0.95. Thus the chondrules (except for KF type) can be divided into three types, SP, IP, and CP, limiting values of 0.65 and 0.95 for the Al/(Al+Na+K) ratio (Table 1). SP chondrules contain a sodic plagioclase component (An_0 to An_{30}) as the normative feldspar, IP chondrules have an intermediate normative plagioclase component (An_{30} to An_{90}), and CP chondrules contain calcic normative plagioclase (An_{90} to An_{100}). CP chondrules are very rare in O chondrites, and the compositional gap between IP and CP types may not be significant. Therefore, the ratio of 0.95 used to divide IP and CP types should be considered tentative.

The chondrules in each of these chemical types have a wide range of SiO_2, Al_2O_3, and CaO contents. Thus, each type can be subdivided on the basis of the ratios, Ca/(Al+Na+K+Ca), Al/(Al+Si+Mg+Fe), and Si/(Si+Mg+Fe), as shown in Table 2. The observed subtypes are summarized in Table 3. The Ca-poor subtype occurs only in SP chondrules. It corresponds to the "type N" category of IKEDA (1980).

4.4. *Correlation between chemical type and texture of chondrules*

Table 4 shows the correlation between chemical type and texture of chondrules in ALH-764 and ALH-77015. The SP chondrules show a variety of textures, and the proportions of porphyritic (or granular), barred-Ol, and radial-Px textures in SP chondrules (except for Ca-poor SP) are about 5:1:3. The Ca-poor SP chondrules usually include a normative nepheline component, and lack a low-Ca pyroxene component. Therefore, Ca-poor SP chondrules never show a radial-Px texture. Most IP chondrules are richer in normative olivine than SP chondrules, and the radial-Px texture is absent or rare among IP chondrules. The proportions of porphyritic (or granular), barred-Ol, and radial-Px textures among IP chondrules are about 3:1:0.

Table 4. Correlation between chemical types and textures of chondrules in ALH-764 and ALH-77015. Numbers of chondrules are shown.

	Porphyritic, granular	Barred-Ol	Radial-Px	Glassy, cryptocrystalline
SP	53	10	31	3
Ca-poor SP	1	3	0	2
IP	18	6	0	1

5. Discussion

Table 5 summarizes the frequency of the chemical types of chondrules in each of the chondrites studied. In the E chondrite, ordinary IP and ordinary SP types predominate, and Si-rich SP chondrules are subordinate. The chemical types of chondrules occur in similar proportions in H, L and non-brecciated LL chondrites, but in the brecciated LL chondrite (Y-74442) KF chondrules are common instead of the IP type. The CP type sometimes occurs in C chondrites, but it is absent or very rare in E and O chondrites.

Table 5. Frequency of chondrule subtypes in each chondrite studied.

	CP	IP		SP				KF
		Al-rich	Ordinary	Al-rich	Ordinary	Si-rich	Ca-poor	
Y-691 (E)	−	−	++	−	+++	+	−	−
Y-790986 (H)	−	+	++	−	+++	+	−	−
ALH-77299 (H)	−	+	++	+	+++	−	+	−
Y-74191 (L)	−	−	++	−	+++	−	+	−
ALH-77015 (L)	−	−	++	−	+++	−	+	−
ALH-764 (LL)	−	−	++	−	+++	−	+	−
Y-74442 (LL)	−	−	+	+	+++	−	+	++
ALH-77003 (C)	+	+	+++	−	++	−	−	−
Y-790992 (C)	+	+	+++	+	++	−	−	−

+++: abundant, ++: common, +: rare, −: absent or very rare.

Table 6. Frequency (percents by number) of chemical types of chondrules. The data of Y-790986 (H) are not shown because the number of the chondrules sampled is too small to be significant.

	CP	IP	SP	KF
Y-691 (E)	0	26	74	0
ALH-77299 (H)	0	18	82	0
Y-74191 (L)	0	22	78	0
ALH-77015 (L)	0	22	78	0
ALH-764 (LL, non-brecciated type)	0	23	77	0
Y-74442 (LL, brecciated type)	0	6	60	34
ALH-77003 (C)	2	67	32	0
Y-790992 (C)	2	66	33	0

In Table 6, the relative abundances of CP, IP, SP and KF chondrules are shown as percentages. The frequency ratio of IP to SP types in H, L and non-brecciated LL chondrites is nearly 1:4, and is surprisingly uniform. The relative amounts of IP and SP in the E chondrite are similar to those in O chondrites (except for brecciated LL type). The brecciated LL type shows decidedly different proportions of chondrule types, namely rare IP and common KF chondrules. This means that the brecciated LL chondrites must have a different origin from the other ordinary chondrites, and probably came from an LL parent body different from that of the non-brecciated LL chondrites.

If unequilibrated LL chondrites of the brecciated type such as Y-74442 including KF chondrules were intensely metamorphosed, potassium feldspar might occur commonly in the resulting equilibrated rocks. However, the most equilibrated LL chondrites contain little or no potassium feldspar. Therefore, it seems more likely that the most equilibrated LL chondrites have a cogenetic relationship with non-brecciated LL chondrites.

The frequency ratio of IP and SP chondrules in C chondrites is about 2:1, which is different from the ratios in E and O chondrites. This means that the precursor of the chondrules in C chondrites may be different in chemical composition as a whole than the precursors of chondrules in O and E chondrites.

The MgO/(MgO+FeO) ratios of chondrules are shown in Fig. 7. The chondrules of C chondrites show a bimodal distribution, with a peak between 0.95 and 0.90 and

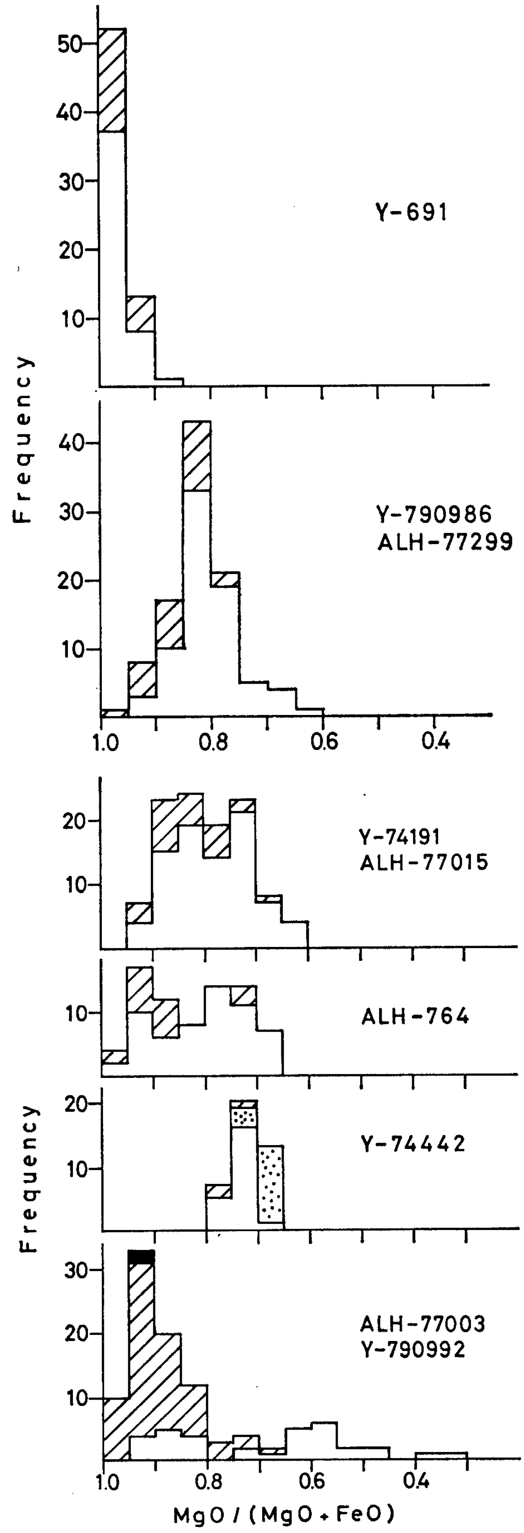

Fig. 7. Frequency distributions of the mole ratio MgO/(MgO+FeO) in chondrites from subsets of chondrites. Dotted areas, KF; open areas, SP; hatched areas, IP; and closed areas, CP types.

a minor broad peak at about 0.6. The former peak is composed of both IP and SP chondrules, whereas the latter peak is occupied by SP chondrules. The ferrous SP chondrules show chemical compositions similar to the matrices of their chondrites, and they are considered to have been produced from a precursor similar to the matrix materials (IKEDA, 1982). The MgO/(MgO+FeO) ratios for Y-74442 are uniform in comparison to the chondrules of other O chondrites. This uniformity may be due partly to the metamorphism that established its petrologic type of 3 to 4, and partly to the original nature of brecciated LL chondrites. (Clean glasses are commonly observed in Y-74442 (IKEDA and TAKEDA, 1979b), and this is characteristic of type 3 chondrites; however the homogeneity of its olivines are more nearly consistent with a type 4 classification.) The frequency pattern of MgO/(MgO+FeO) ratios in the chondrules of ALH-764, shown in Fig. 7, resembles those of Y-74191 and ALH-77015, indicating that the chondrules of non-brecciated LL chondrites have the origin similar to those of unequilibrated L chondrites. The frequency pattern in H chondrites shows a peak at 0.85 to 0.80, which corresponds to the range of olivine compositions in equilibrated H chondrites. The E chondrite peaks in the range 1.0 to 0.95, although some of the iron reported as FeO in the chondrules of Y-691 may be metallic Fe finely mixed in the groundmass of chondrules.

The most abundant in O chondrites are ordinary SP chondrules, and they show atomic Al/(Al+Na+K) ratios similar to that of the solar system abundance of 0.57 (CAMERON, 1973). Therefore, according to the condensation theory (GROSSMAN and LARIMER, 1974), assuming a total gas pressure of 10^{-4} atm, the precursor material of ordinary SP chondrules may be condensates at temperatures of 1100 to 700 K, *i.e.*, in the temperature range after alkali condensation and prior to the main introduction of FeO into the condensates. IP chondrules tend to be poorer in alkalis and SiO_2, and richer in MgO, than ordinary SP chondrules, indicating that the precursor material of IP chondrules may include more high-temperature fraction than that of ordinary SP chondrules. Some IP chondrules may have been produced through alkali-loss from SP chondrules by a high-temperature process. On the other hand, most Ca-poor SP chondrules contain normative olivine, albite, and nepheline, and have chemical compositions similar to that of the matrix in Y-74191 (IKEDA *et al.*, 1981), except for slightly more magnesian nature of Ca-poor SP chondrules. Thus, the precursor material of the Ca-poor SP chondrules may correspond to lower- and higher-temeprature condensates than the precursor of ordinary SP chondrules and the matrix in Y-74191, respectively.

6. Conclusions

(1) The chemical compositions of most chondrules can be represented as mixtures in various proportions of olivine and low-Ca pyroxene, with minor but constant amounts of feldspar (and/or feldspathoid) and high-Ca pyroxene; a few chondrules, however, contain large amounts of feldspar, high-Ca pyroxene, spinel, and/or SiO_2-minerals.

(2) The chondrules in non-brecciated LL chondrites have decidedly different proportions of chemical types of chondrules than those in brecciated LL chondrites,

but have the same proportions of chemical types as the chondrules in unequilibrated L chondrites.

(3) The H, L, and non-brecciated LL chondrites have a surprisingly uniform frequency ratio of IP to SP chondrules, about 1:4.

(4) Chondrules in E chondrite tend to be rich in SiO_2, and have a frequency ratio of IP to SP chondrule types that is similar to that of O chondrites (except for brecciated LL type).

(5) The chondrules of C chondrites have a frequency ratio of IP to SP chondrules that differs from the O chondrites, being about 2:1.

(6) The precursor material of ordinary SP chondrules is considered to be condensates at 1100 to 700 K, and that of Ca-poor SP chondrules may be lower temperature condensates than that of ordinary SP chondrules.

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Appendix

Chemical compositions of chondrules in the Y-691(E), ALH-77299(H), Y-790986 (H), ALH-77015(L), and Y-790992(C) chondrites. Analytical method is shown in text. As the opaque minerals such as Fe-Ni metals and troilite in chondrules are omitted from the analyses, the chemical compositions in this appendix are mainly of silicate portions of chondrules. Horizontal bars are components not determined.

	Y-691													
	1	2	3	4	5	7	8	9	10	12	14	15	15'	16
Na_2O	0.88	0.37	0.97	0.51	1.61	1.69	1.58	0.44	0.86	1.42	0.79	0.10	0.00	0.77
MgO	38.56	32.64	35.34	30.18	33.03	36.70	32.70	30.04	39.13	30.99	36.18	32.64	1.09	36.19
Al_2O_3	1.53	0.72	1.78	1.74	3.33	3.37	2.65	1.09	2.62	2.74	1.95	0.22	0.00	1.69
SiO_2	52.44	56.16	57.77	59.93	55.27	51.50	55.00	61.57	51.77	56.36	55.14	58.50	94.16	55.44
K_2O	0.10	0.13	0.12	0.00	0.34	0.37	0.12	0.09	0.07	0.11	0.08	0.00	0.00	0.21
CaO	1.03	1.84	1.06	1.54	1.73	2.13	1.61	1.07	1.75	1.47	1.94	0.04	0.57	1.05
TiO_2	-	-	-	-	-	-	-	-	-	0.00	-	-	-	0.00
Cr_2O_3	0.34	0.80	0.20	-	-	0.28	-	0.32	0.28	-	0.07	-	-	-
MnO	-	-	-	0.25	0.51	-	0.34	-	-	0.17	-	0.14	0.03	0.16
FeO	2.92	5.92	1.42	2.58	0.97	1.74	1.92	3.59	2.40	2.36	2.12	5.03	1.84	1.37
Total	97.80	98.58	98.66	96.66	96.79	97.78	95.92	98.21	98.88	95.62	98.27	96.67	97.69	96.86

	Y-691												
	17	18	19	20	21	22	23	28	29	30	31	34	34'
Na_2O	1.23	0.47	0.89	0.64	1.28	0.74	1.09	0.91	1.06	0.69	0.46	0.07	0.00
MgO	26.08	38.25	34.09	29.75	32.25	26.60	37.84	35.65	27.31	35.48	35.39	31.99	44.32
Al_2O_3	4.77	3.02	2.25	1.65	2.69	2.09	2.25	2.28	1.76	2.34	0.99	0.31	0.00
SiO_2	58.61	49.66	60.55	61.22	56.30	62.49	51.57	52.43	62.20	53.61	57.90	56.84	51.32
K_2O	0.10	0.00	0.34	0.09	0.09	0.10	0.17	0.18	0.08	0.04	0.05	0.00	0.00
CaO	4.04	2.97	1.26	1.52	1.08	1.58	1.63	1.42	0.98	2.44	0.55	0.44	0.00
TiO_2	-	-	0.10	-	0.00	-	0.06	0.00	-	-	0.00	-	-
Cr_2O_3	0.13	-	-	0.32	-	0.54	-	-	-	-	-	-	-
MnO	-	0.16	0.18	-	1.15	-	0.01	0.35	0.23	0.16	0.00	0.14	0.14
FeO	1.51	2.30	0.87	2.98	1.76	3.42	1.82	2.56	2.71	3.85	2.93	7.42	3.78
Total	96.47	96.83	100.53	98.17	95.60	97.56	96.44	95.78	96.32	98.61	98.27	97.21	99.56

	Y-691												
	37	38	44	45'	47	48	65	69	78	79	86	93	94
Na_2O	0.02	0.57	1.02	1.11	1.31	0.91	0.29	0.08	1.15	0.74	0.76	1.48	2.50
MgO	45.12	33.76	37.61	34.43	31.37	30.17	32.13	46.31	28.87	31.64	28.75	44.38	14.42
Al_2O_3	0.36	2.46	2.40	3.15	2.28	1.80	0.62	0.18	2.68	1.34	1.34	3.42	5.00
SiO_2	51.96	57.64	54.89	56.60	59.54	61.70	59.80	52.12	61.11	60.28	62.50	44.73	62.11
K_2O	0.00	0.07	0.08	0.09	0.16	0.09	0.00	0.05	0.51	0.06	0.12	0.38	1.09
CaO	0.40	2.30	1.86	2.18	1.06	1.26	0.25	0.20	2.26	0.71	0.67	2.46	4.32
TiO_2	-	-	-	-	-	0.10	-	0.05	0.14	0.10	-	-	-
Cr_2O_3	-	0.25	0.22	0.27	0.12	-	-	-	-	-	0.36	0.27	0.59
MnO	0.12	-	-	-	-	0.00	0.31	0.00	0.03	0.00	-	-	-
FeO	1.37	1.44	1.51	1.76	2.87	2.58	3.62	0.77	1.84	2.17	2.86	1.35	4.25
Total	99.37	98.49	99.59	99.59	98.71	98.61	97.02	99.76	98.59	96.30	97.36	98.47	94.28

	Y-691												
	96	97	101	103	104	105	106	108	109	110	111	112	114
Na_2O	0.00	0.89	0.53	0.49	0.97	0.77	1.10	0.98	0.98	0.42	0.40	0.63	0.90
MgO	39.40	34.27	28.80	38.62	33.65	35.78	33.19	32.38	35.09	34.98	29.51	30.47	35.05
Al_2O_3	0.00	2.00	1.88	1.08	1.96	2.81	2.18	2.29	2.36	0.76	1.52	1.19	2.79
SiO_2	59.95	57.00	59.49	52.64	58.66	55.57	58.32	58.03	56.23	58.67	61.50	59.82	51.96
K_2O	0.00	0.02	0.88	0.10	0.33	0.02	0.07	0.42	0.07	0.03	0.05	0.05	0.05
CaO	0.08	1.26	1.70	0.93	1.06	2.57	0.76	1.31	1.38	0.46	1.92	0.44	2.75
TiO_2	-	0.00	-	-	-	-	0.00	0.00	0.00	-	-	0.00	0.00
Cr_2O_3	-	-	0.50	-	-	-	-	-	-	-	0.83	-	-
MnO	0.35	0.05	-	0.00	0.12	0.17	0.24	0.16	0.22	0.12	-	0.25	0.41
FeO	2.53	1.49	3.41	2.56	1.14	2.06	1.62	0.72	1.51	1.19	2.51	2.99	4.24
Total	98.30	96.98	96.39	96.42	97.89	99.75	97.48	96.29	97.84	96.63	98.24	95.84	98.15

	Y-691												
	115	117	123	124	128	130	132	133	134	135	136	138	141
Na_2O	0.45	1.60	1.00	0.46	0.90	0.74	0.39	0.45	0.87	1.23	1.34	0.45	0.56
MgO	35.29	27.26	31.11	36.35	35.23	39.71	41.57	32.59	30.98	16.15	35.43	36.50	33.44
Al_2O_3	2.25	3.18	2.03	0.91	1.59	2.63	5.32	0.69	1.60	3.23	2.30	3.64	2.31
SiO_2	54.92	60.71	57.53	56.52	56.95	51.09	41.12	58.60	59.19	68.17	55.76	49.84	54.73
K_2O	0.03	0.14	0.05	0.04	0.05	0.02	0.00	0.02	0.07	0.29	0.11	0.01	0.07
CaO	2.09	1.28	1.04	0.87	1.18	2.53	4.78	0.38	0.97	4.22	1.20	3.41	1.63
TiO_2	0.05	0.00	0.00	-	-	-	0.16	-	0.00	-	-	0.02	-
Cr_2O_3	-	-	-	-	-	-	-	-	-	0.08	-	-	0.16
MnO	0.31	0.22	0.15	0.02	0.26	0.47	0.14	0.17	0.23	-	0.19	0.13	-
FeO	1.92	1.72	3.07	1.15	0.66	1.59	6.71	5.05	3.38	1.25	2.84	3.59	3.53
Total	97.31	96.11	95.98	96.32	96.82	98.78	100.19	97.95	97.29	94.62	99.20	97.59	96.43

	Y-691											
	143	149	150	156	157	176	184	185	185'	186	188	189
Na_2O	0.62	1.37	0.39	0.80	0.48	0.91	0.08	0.50	0.19	0.59	0.10	1.24
MgO	34.18	27.92	32.54	31.54	36.33	34.40	41.25	43.77	47.39	36.87	42.52	38.09
Al_2O_3	1.10	2.42	0.68	2.72	3.27	1.78	0.87	1.20	1.46	1.34	0.12	4.61
SiO_2	56.11	61.68	55.99	58.63	52.32	56.04	52.06	52.38	40.23	58.34	50.97	46.62
K_2O	0.09	0.32	0.10	0.04	0.01	0.08	0.00	0.05	0.01	0.16	0.00	0.10
CaO	0.04	1.70	1.41	2.57	2.11	0.86	0.99	0.51	1.20	0.88	0.20	3.78
TiO_2	0.00	-	-	-	-	0.00	0.01	0.09	0.09	-	0.02	-
Cr_2O_3	-	-	1.10	-	-	-	-	-	-	0.01	-	0.42
MnO	0.06	0.36	-	0.07	0.00	0.28	0.00	0.00	0.00	-	0.00	-
FeO	3.27	1.66	5.47	1.03	4.49	3.53	3.98	1.60	10.64	1.11	6.66	4.59
Total	95.83	97.43	97.68	97.40	99.01	97.88	99.24	100.10	101.21	99.30	100.60	99.45

	Y-691									
	191	194	195	198	199	202	206	207	210	212
Na_2O	0.52	0.62	2.14	0.08	0.08	0.17	0.14	0.05	0.12	0.25
MgO	33.54	31.92	23.11	42.72	41.05	43.56	37.32	45.74	35.63	35.59
Al_2O_3	1.23	1.43	4.91	0.24	1.16	0.17	0.22	0.18	0.34	1.93
SiO_2	52.84	58.79	50.43	46.85	49.23	51.08	52.76	51.79	57.10	56.59
K_2O	0.17	0.05	0.22	0.01	0.00	0.03	0.01	0.00	0.01	0.00
CaO	2.02	0.86	2.21	1.07	1.54	0.45	0.66	0.24	0.31	1.83
TiO_2	0.00	0.00	-	0.00	0.02	0.00	0.00	0.07	0.00	-
Cr_2O_3	-	-	0.79	-	-	-	-	-	-	-
MnO	0.20	0.24	-	0.07	0.08	0.14	0.00	0.00	0.08	0.20
FeO	6.39	3.70	12.89	7.12	4.19	2.36	7.69	2.65	3.84	2.34
Total	96.91	97.61	96.70	98.16	97.35	97.96	98.79	100.76	97.43	98.70

	ALH-77299												
	1	1'	3	4	7	8	9	10	10'	11	13	15	15'
Na_2O	0.53	0.64	1.13	1.53	0.78	1.07	1.09	1.24	0.29	1.13	0.32	0.80	1.84
MgO	40.64	33.76	32.99	33.54	29.90	40.14	31.11	32.47	37.55	32.00	35.99	23.71	32.61
Al_2O_3	3.40	1.49	2.21	4.09	2.76	2.02	2.34	5.03	1.63	2.17	1.44	2.02	3.85
SiO_2	44.23	54.39	41.83	49.65	51.07	45.89	51.61	40.88	46.68	42.32	43.61	51.60	46.37
K_2O	0.04	0.23	0.06	1.40	0.03	0.14	0.07	0.14	0.02	0.14	0.02	0.83	0.07
CaO	3.19	1.34	2.76	2.98	2.33	1.01	2.03	3.13	1.59	2.84	1.13	1.85	1.94
TiO_2	-	-	-	-	-	-	-	-	-	-	-	-	-
Cr_2O_3	0.66	0.77	0.37	0.82	0.73	-	0.75	0.36	0.64	-	0.51	-	0.77
MnO	-	-	-	-	-	0.33	-	-	-	0.47	-	0.63	-
FeO	7.81	7.30	18.28	5.40	10.85	8.65	10.85	15.04	9.61	17.43	16.11	18.27	11.61
Total	100.50	99.92	99.63	99.41	98.45	99.25	99.85	98.29	98.01	98.50	99.13	99.68	99.06

	ALH-77299												
	17	21	22	23	23'''	26	27	32	39	40	41	42	43
Na_2O	0.34	1.21	0.82	0.65	2.43	0.67	1.34	2.50	1.73	2.21	0.79	1.48	1.27
MgO	37.84	31.61	33.12	32.71	29.00	20.71	30.72	29.98	28.38	25.37	28.55	29.97	33.46
Al_2O_3	3.55	2.51	2.92	2.70	4.92	1.18	2.72	4.73	3.21	7.50	1.66	2.76	2.23
SiO_2	41.14	47.26	52.70	48.12	47.22	53.99	45.90	41.90	50.31	47.88	54.74	47.97	45.64
K_2O	0.02	0.14	0.05	0.02	0.11	0.13	0.18	0.18	0.15	0.06	0.10	0.10	0.07
CaO	2.72	2.43	2.84	2.45	3.44	1.21	2.53	0.14	3.67	4.76	2.07	3.31	2.21
TiO_2	-	-	-	-	-	-	-	-	-	-	-	-	-
Cr_2O_3	0.46	-	0.96	0.75	0.33	-	-	-	0.76	1.10	0.91	0.61	0.62
MnO	-	0.41	-	-	-	1.06	0.48	0.36	-	-	-	-	-
FeO	15.68	13.17	6.33	12.63	11.46	18.12	12.72	15.43	11.40	10.42	10.22	12.56	14.07
Total	101.75	98.74	99.79	100.03	98.91	98.74	96.59	95.22	99.61	99.30	99.04	98.76	99.57

	ALH-77299												
	46	47	49	49'	56	57	60	61	63	63'	64	66	67
Na_2O	1.07	0.32	0.89	3.80	1.01	1.20	1.76	0.77	0.56	0.84	1.90	1.25	0.69
MgO	30.21	38.58	32.49	13.96	33.96	26.83	28.22	28.29	23.55	38.59	24.79	22.14	27.44
Al_2O_3	2.05	2.70	1.90	10.00	2.37	1.98	3.43	1.72	1.30	2.12	4.20	10.00	1.82
SiO_2	47.65	39.65	46.68	54.53	49.23	48.32	48.14	52.91	53.38	42.39	55.77	49.87	55.66
K_2O	0.04	0.03	0.05	2.34	0.56	0.09	0.05	0.05	0.33	0.43	0.14	0.05	0.57
CaO	1.83	2.09	1.59	7.07	2.03	3.74	4.59	2.53	1.45	0.99	1.68	8.23	2.15
TiO_2	-	-	-	-	-	-	-	-	-	-	-	-	-
Cr_2O_3	0.70	0.38	0.77	0.59	0.73	0.48	0.27	-	0.79	0.42	0.70	0.42	0.83
MnO	-	-	-	-	-	-	-	0.37	-	-	-	-	-
FeO	16.65	17.75	16.21	3.81	8.62	14.64	10.97	12.64	15.83	12.81	8.15	4.70	8.26
Total	100.20	101.50	100.58	96.10	98.51	97.28	97.43	99.28	97.66	98.59	97.33	96.66	97.42

	ALH-77299												
	68	69	70	71	72	73	74	77	78	79	82	83	83'
Na_2O	0.33	0.62	1.27	0.92	0.52	1.50	1.42	1.10	0.89	2.18	1.24	1.26	0.09
MgO	36.07	23.50	29.58	27.64	26.00	33.78	29.58	32.04	26.43	34.86	28.95	32.51	34.60
Al_2O_3	1.32	1.41	2.69	1.81	0.99	3.49	2.53	2.09	1.59	5.32	2.72	2.67	1.11
SiO_2	48.40	47.24	49.05	54.41	56.03	48.20	51.69	42.61	52.89	48.31	50.98	49.23	52.93
K_2O	0.03	0.18	0.02	0.02	0.03	0.90	0.02	0.38	0.06	1.80	0.03	0.06	0.00
CaO	1.15	1.24	3.94	1.70	1.31	2.43	1.94	1.97	1.71	0.76	1.61	1.29	1.12
TiO_2	-	-	-	-	-	-	-	-	-	-	-	-	-
Cr_2O_3	0.54	-	0.70	0.78	0.55	0.71	0.79	0.53	0.51	0.61	0.91	0.66	0.89
MnO	-	0.58	-	-	-	-	-	-	-	-	-	-	-
FeO	11.69	23.47	12.11	10.79	14.16	6.06	10.38	18.26	12.35	5.94	11.42	11.11	7.46
Total	99.47	98.24	99.36	98.07	99.59	97.07	98.35	98.98	96.43	99.78	97.86	98.79	98.20

	ALH-77299												
	86	90	90'	91	92	94	96	100'	100	102	103	104	105
Na_2O	0.48	1.14	0.47	0.97	1.48	0.76	1.42	1.01	0.69	0.05	1.15	0.32	0.90
MgO	31.65	26.21	27.00	33.48	30.39	33.73	29.15	32.01	21.89	39.26	32.45	31.39	25.10
Al_2O_3	1.99	2.09	0.75	1.61	2.39	1.84	2.18	1.70	1.66	0.46	2.66	1.06	1.42
SiO_2	48.82	45.54	54.62	43.17	47.69	50.10	53.04	46.50	57.28	42.59	48.27	54.34	52.25
K_2O	0.01	0.07	0.00	0.10	0.16	0.70	0.11	0.08	0.62	0.00	0.01	0.00	0.06
CaO	1.19	1.14	2.33	2.36	2.41	1.56	1.88	3.85	1.45	0.38	1.13	1.29	1.67
TiO_2	-	-	-	-	-	-	-	-	-	-	-	-	-
Cr_2O_3	0.74	-	0.36	0.43	0.58	-	-	-	0.70	0.37	0.67	0.90	-
MnO	-	0.45	-	-	-	0.49	0.71	0.51	-	-	-	-	0.77
FeO	14.35	18.86	11.30	16.52	13.86	7.37	11.36	12.70	15.47	15.79	14.30	9.27	15.78
Total	99.23	95.50	96.83	98.64	98.96	96.55	99.98	98.46	99.76	98.90	100.64	98.57	97.95

	ALH-77299												
	106	110	113	120	127	128	133	134	135	138	139	141	143
Na_2O	0.92	1.25	1.60	0.71	0.72	1.55	1.34	0.94	1.01	1.41	0.86	1.81	0.49
MgO	24.99	30.64	27.53	27.59	33.52	24.74	30.71	24.41	27.62	28.22	27.50	34.87	35.27
Al_2O_3	1.60	2.09	2.72	1.25	1.44	2.68	2.80	1.52	4.68	2.42	1.79	3.37	1.23
SiO_2	58.02	47.38	49.35	55.59	39.70	45.41	47.48	53.10	50.38	50.52	54.32	39.50	54.44
K_2O	0.06	0.07	0.10	0.06	0.02	0.07	0.03	0.08	0.01	0.13	0.02	0.09	0.26
CaO	1.43	2.88	4.35	1.13	1.28	2.03	1.27	0.18	4.46	2.62	2.34	0.50	1.29
TiO_2	-	-	-	-	-	-	-	-	-	-	-	-	-
Cr_2O_3	0.78	-	-	-	0.34	0.68	0.68	-	0.75	-	0.51	-	0.61
MnO	-	0.44	0.41	0.52	-	-	-	0.70	-	0.45	-	0.28	-
FeO	11.33	13.87	11.34	12.17	21.56	19.35	15.20	16.41	7.83	12.08	11.46	19.02	4.55
Total	99.13	98.62	97.49	99.02	98.58	96.51	99.51	97.34	96.74	97.85	98.80	99.44	98.14

	ALH-77299									
	144	144'	147	148A	149	150	151	152	154	158
Na_2O	4.00	1.13	0.35	0.96	2.50	1.17	0.68	1.23	0.82	0.77
MgO	21.87	26.23	19.60	29.44	31.63	31.32	26.45	34.19	30.81	26.97
Al_2O_3	8.80	1.93	0.71	1.67	4.45	1.86	1.54	2.93	1.98	1.92
SiO_2	49.13	58.11	53.88	58.56	45.54	50.19	54.71	50.52	54.76	57.04
K_2O	0.21	0.04	0.22	0.03	0.43	0.10	0.34	0.82	0.68	0.06
CaO	1.37	2.04	1.12	1.21	0.27	1.91	1.74	2.20	1.68	2.02
TiO_2	-	-	-	-	-	-	-	-	-	-
Cr_2O_3	0.32	1.08	-	-	-	-	-	0.92	0.52	-
MnO	-	-	1.19	0.80	0.25	0.54	0.85	-	-	0.47
FeO	12.48	8.66	23.31	7.79	12.34	12.27	13.07	7.21	5.33	9.53
Total	98.18	99.22	100.51	100.46	97.41	99.46	99.28	99.92	96.58	98.78

	Y-790986												
	1	3	4	5'	6	7	9	12	16	17	36	38	41
Na_2O	1.69	0.71	0.53	1.98	0.47	1.41	1.76	0.85	0.79	0.65	0.95	1.17	1.42
MgO	31.28	26.58	29.77	22.66	34.00	25.05	26.13	25.26	21.75	20.82	25.81	32.97	27.05
Al_2O_3	2.99	1.69	2.31	8.12	2.05	3.39	2.81	1.67	1.51	1.34	2.16	2.10	2.34
SiO_2	48.44	51.64	52.65	51.49	43.13	57.61	50.77	52.65	60.07	56.64	57.58	45.50	58.27
K_2O	0.39	0.25	0.02	0.09	0.04	0.04	0.05	0.18	0.03	0.18	0.08	0.20	0.20
CaO	1.58	1.53	1.56	5.42	0.97	1.33	7.08	2.48	2.90	2.27	1.46	2.12	2.24
TiO_2	-	-	-	0.41	-	0.17	0.14	-	0.21	0.14	-	-	0.22
Cr_2O_3	0.67	0.90	0.95	-	0.76	-	-	1.20	-	-	1.20	0.83	-
MnO	-	-	-	0.42	-	0.47	0.30	-	0.34	0.50	-	-	0.71
FeO	11.83	12.58	9.68	7.82	14.25	9.23	9.18	13.06	9.40	14.05	7.74	13.58	5.89
Total	98.87	95.88	97.47	98.42	95.67	98.70	98.22	97.95	97.00	96.59	96.98	98.47	98.35

	Y-790986							
	42	45	46	49	51	52	53	54
Na_2O	0.67	0.62	0.49	1.12	1.16	2.80	1.38	3.23
MgO	19.91	28.72	33.48	33.21	34.71	11.83	25.65	19.71
Al_2O_3	1.11	2.05	3.49	2.43	3.07	4.50	2.58	11.09
SiO_2	55.08	57.15	42.89	46.44	46.51	61.77	50.99	49.75
K_2O	0.12	0.08	0.00	0.20	0.03	0.53	0.19	0.20
CaO	3.24	1.22	2.45	2.24	1.90	6.38	4.57	8.23
TiO_2	-	0.04	-	-	-	0.17	-	-
Cr_2O_3	0.84	-	0.83	0.88	0.87	-	0.85	0.39
MnO	-	0.29	-	-	-	0.76	-	-
FeO	14.28	7.57	11.94	12.20	12.15	11.13	9.74	5.17
Total	95.25	97.75	95.57	98.72	100.40	99.88	95.95	97.77

	ALH-77015												
	1	2	3	4	5	6	8	9	10	11	12	13	14
Na_2O	0.16	0.82	1.03	0.97	0.65	0.24	1.02	0.46	0.84	1.09	0.97	0.26	0.36
MgO	32.67	24.16	27.24	25.45	31.46	37.74	24.63	43.61	23.96	30.88	21.62	39.63	37.58
Al_2O_3	2.61	1.88	1.53	1.60	5.54	2.26	1.80	0.85	1.44	1.72	1.60	0.56	0.45
SiO_2	42.66	52.78	55.11	48.52	51.93	39.91	54.23	44.61	52.88	42.82	50.83	39.98	40.07
K_2O	0.00	0.60	0.06	0.07	0.02	0.00	0.00	0.01	0.00	0.09	0.01	0.05	0.06
CaO	2.67	1.76	1.58	1.26	6.57	1.81	1.47	0.93	1.46	1.21	1.49	0.46	0.68
TiO_2	-	-	-	-	-	-	-	-	-	-	-	-	-
Cr_2O_3	0.90	0.88	0.82	0.98	0.66	0.77	0.92	0.55	1.05	0.66	0.98	0.99	0.57
MnO	-	-	-	-	-	-	-	-	-	-	-	-	-
FeO	18.48	16.87	8.55	20.39	3.67	17.65	15.69	6.53	17.68	20.98	20.32	14.69	18.64
Total	100.57	99.75	95.92	99.22	100.50	100.38	99.76	97.55	99.31	99.43	97.41	96.62	98.41

	ALH-77015												
	15	16	17	20	32	34	37	38	41	42	50	51	58
Na_2O	0.37	1.21	1.37	0.63	1.29	0.27	1.18	1.23	1.51	0.54	0.68	1.13	0.97
MgO	36.58	25.90	33.96	20.55	25.73	34.01	28.16	24.61	29.10	28.19	33.27	30.68	25.97
Al_2O_3	2.26	1.97	2.28	0.92	2.00	2.34	1.83	1.81	2.66	1.23	3.13	2.52	1.69
SiO_2	49.20	54.45	47.29	51.69	47.97	52.78	42.77	45.85	53.81	51.62	44.73	47.85	45.59
K_2O	0.00	0.00	0.03	0.01	0.08	0.00	0.13	0.04	0.00	0.00	0.04	0.52	0.30
CaO	1.98	2.12	2.10	1.38	1.89	1.91	2.05	1.72	2.58	1.27	2.87	1.98	1.85
TiO_2	-	-	-	-	-	-	-	-	-	-	-	-	-
Cr_2O_3	0.92	0.94	0.87	0.94	0.94	0.66	0.59	0.68	1.09	0.94	0.90	0.77	0.80
MnO	-	-	-	-	-	-	-	-	-	-	-	-	-
FeO	8.23	13.06	11.98	21.46	19.09	6.35	20.29	20.50	8.49	14.44	11.42	12.53	21.02
Total	99.54	99.65	99.88	97.58	98.99	98.32	97.00	96.44	99.24	98.23	96.94	97.93	98.19

	ALH-77015												
	60	61	64	72	73	75	76	77	78	80	81	82	86
Na_2O	1.08	0.91	0.62	1.61	1.26	0.43	0.83	1.42	1.34	0.87	0.16	0.98	0.95
MgO	35.03	43.77	32.87	27.76	42.23	34.04	35.07	32.67	27.21	17.79	30.42	27.72	27.66
Al_2O_3	2.60	2.36	4.56	2.48	2.32	2.30	2.13	3.15	2.49	1.15	1.27	1.51	1.50
SiO_2	47.32	42.51	46.18	44.42	39.77	51.30	49.72	48.01	55.90	52.01	39.97	42.05	55.95
K_2O	0.54	0.55	0.02	0.05	0.35	0.00	0.04	0.05	0.02	0.00	0.00	0.10	0.02
CaO	1.73	0.18	3.83	2.31	0.38	2.48	1.65	1.99	1.81	1.06	1.38	1.69	2.28
TiO_2	-	-	-	-	-	-	-	-	-	-	-	-	-
Cr_2O_3	0.98	0.39	0.36	0.77	0.48	0.42	0.81	0.69	1.34	0.69	0.43	0.63	0.86
MnO	-	-	-	-	-	-	-	-	-	-	-	-	-
FeO	10.80	8.49	7.03	19.43	12.19	7.06	8.52	8.43	8.99	22.36	24.19	23.90	8.74
Total	100.08	99.16	95.47	98.98	98.98	97.97	98.51	96.41	99.10	97.62	97.82	98.58	97.96

	ALH-77015													
	88	91	97	98	100	100'	103	105	106	109	110	111	112	112'
Na_2O	0.96	1.52	0.23	0.67	1.33	0.13	1.18	1.44	0.67	1.37	0.61	1.00	1.51	1.72
MgO	22.21	26.51	25.95	25.60	29.85	43.74	23.15	28.42	29.95	32.57	30.58	30.88	26.71	33.72
Al_2O_3	1.77	2.37	2.81	1.10	2.46	1.11	1.85	2.16	1.05	2.75	1.51	1.77	2.65	2.50
SiO_2	43.75	55.62	45.52	54.05	55.55	41.42	45.69	42.51	46.56	49.30	51.69	56.18	46.65	48.08
K_2O	0.42	0.11	0.00	0.01	0.01	0.00	0.10	0.02	0.00	0.03	0.00	0.10	0.06	0.01
CaO	3.58	2.06	2.43	1.39	2.29	1.18	1.57	1.80	1.40	2.01	1.67	1.76	2.15	2.40
TiO_2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cr_2O_3	0.60	0.80	0.76	0.86	0.87	0.49	0.67	0.55	0.73	0.85	0.77	0.73	0.75	0.83
MnO	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FeO	26.26	7.48	20.52	11.87	5.77	10.18	24.18	19.92	15.94	10.30	10.37	5.73	16.86	8.95
Total	99.64	96.47	98.18	95.55	98.13	98.25	98.39	96.82	96.30	99.18	97.20	98.15	97.34	98.21

	Y-790992													
	3	8	12	14	17	18	19	23	24	31	33	43	44	51
Na_2O	0.54	0.10	0.26	0.89	0.98	1.67	0.23	0.85	0.87	1.39	0.07	0.13	0.20	0.33
MgO	44.93	53.55	32.95	36.67	17.03	23.38	46.27	37.42	23.79	28.56	43.24	39.76	48.67	50.47
Al_2O_3	2.73	0.60	4.12	2.56	1.50	8.52	2.69	5.63	6.69	6.17	1.79	0.69	1.45	0.78
SiO_2	46.79	40.19	55.64	49.48	38.52	52.03	42.13	44.46	49.78	49.66	39.98	47.60	43.68	40.17
K_2O	0.04	0.02	0.02	0.09	0.02	0.14	0.02	0.07	0.06	0.13	0.01	0.02	0.02	0.01
CaO	2.24	0.59	3.03	3.27	3.42	6.94	2.16	4.51	7.11	6.02	4.01	0.97	1.39	0.66
TiO_2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cr_2O_3	0.39	0.08	0.53	0.85	0.64	0.38	0.57	0.55	0.85	0.49	0.56	1.13	0.31	0.32
MnO	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FeO	3.09	2.26	0.92	5.57	34.67	5.13	5.52	4.87	6.42	4.36	6.09	8.06	2.93	6.38
Total	100.75	97.39	97.47	99.28	96.78	98.19	99.59	98.36	95.57	96.78	95.75	98.36	98.65	99.12

	Y-790992											
	63	66	69	74	75	76	81	86	88	95	97	104
Na_2O	0.42	2.33	0.60	0.48	0.32	1.48	0.39	1.79	0.35	0.38	0.31	0.22
MgO	43.01	34.49	42.37	36.37	45.57	25.96	40.59	23.45	40.03	43.07	31.54	40.42
Al_2O_3	2.57	4.22	3.73	2.00	1.56	4.45	2.60	12.42	2.15	2.56	1.22	2.37
SiO_2	42.90	41.95	44.31	49.48	44.38	54.42	43.53	44.63	48.93	45.23	50.06	48.39
K_2O	0.03	0.09	0.04	0.04	0.03	0.05	0.04	0.10	0.03	0.03	0.04	0.02
CaO	2.44	2.83	3.42	2.03	1.09	6.20	2.99	7.52	2.45	2.07	2.21	1.98
TiO_2	-	-	-	-	-	-	-	-	-	-	-	-
Cr_2O_3	0.64	0.81	0.83	0.66	0.63	1.06	0.94	0.71	0.69	0.67	0.74	0.99
MnO	-	-	-	-	-	-	-	-	-	-	-	-
FeO	7.60	13.65	4.64	6.07	6.31	5.15	8.82	8.60	4.88	6.23	13.32	5.04
Total	99.61	100.37	99.94	97.13	99.89	98.77	99.90	99.22	99.51	100.24	99.44	99.43

	Y-790992												
	108	109	111	114	119	122	124-2	126	130	131	136	146	158
Na_2O	0.40	1.09	0.63	0.11	0.35	0.50	0.44	0.78	0.88	1.24	0.29	4.66	0.64
MgO	9.62	28.12	33.50	41.14	33.29	40.94	35.50	37.96	20.99	29.55	40.60	22.96	37.57
Al_2O_3	0.94	2.71	2.17	4.63	3.85	6.05	5.35	4.07	4.03	2.18	1.92	7.06	5.24
SiO_2	40.47	37.35	56.65	39.48	55.56	43.20	49.57	45.90	55.16	55.67	47.59	43.34	40.69
K_2O	0.05	0.03	0.04	0.02	0.04	0.03	0.03	0.06	0.03	0.05	0.04	0.15	0.05
CaO	11.25	1.71	2.93	4.69	3.08	6.03	3.44	4.04	8.19	5.04	1.98	3.71	5.31
TiO_2	-	-	-	-	-	-	-	-	-	-	-	-	-
Cr_2O_3	0.34	1.97	1.14	0.17	0.67	0.50	0.18	1.06	1.09	1.03	1.20	0.15	0.39
MnO	-	-	-	-	-	-	-	-	-	-	-	-	-
FeO	34.40	25.59	3.43	7.36	1.24	1.50	4.29	4.94	6.43	4.32	5.51	15.09	7.95
Total	97.74	98.57	100.48	97.61	98.09	98.75	98.80	98.81	96.80	99.06	99.13	97.12	97.84

	Y-790992			
	159	167	179	181
Na_2O	1.39	2.61	1.43	0.39
MgO	43.23	32.27	17.95	31.18
Al_2O_3	2.37	5.68	1.64	2.22
SiO_2	40.75	49.47	37.63	59.76
K_2O	0.06	0.08	0.02	0.02
CaO	1.22	4.48	3.55	3.04
TiO_2	-	-	-	-
Cr_2O_3	0.62	1.34	0.56	0.71
MnO	-	-	-	-
FeO	9.16	5.13	35.89	1.09
Total	98.80	101.06	98.63	98.41